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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/856,823	05/29/2001	Shin Hashimoto	0819-559	3480

7590 08/05/2002

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EXAMINER	
SONG, MATTHEW J	
ART UNIT	**PAPER NUMBER**
1765	6

DATE MAILED: 08/05/2002

Please find below and/or attached an Office communication concerning this application or proceeding.

PTO-90C (Rev. 07-01)

mk-6

Office Action Summary	Application No.	Applicant(s)
	09/856,823	HASHIMOTO ET AL.
	Examiner	Art Unit
	Matthew J Song	1765

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☐ Responsive to communication(s) filed on _____ .

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-14* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-14* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *29 May 2001* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) *4,5* .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____

DETAILED ACTION

Claim Rejections - 35 USC § 112

1. The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

2. Claim 10 recites the limitation "the said particle beam" in line 8. There is insufficient antecedent basis for this limitation in the claim.

3. Claims 9 and 14 rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. Applicant has claim an oxygen concentration of 4×10^{14}- 4×10^{15} cm^{-2}, but concentration is a function of volume, therefore the claim is indefinite.

Claim Rejections - 35 USC § 102

4. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

5. Claims 1 and 6-8 are rejected under 35 U.S.C. 102(b) as being anticipated by Tung (US 5,728,625).

Tung discloses a process for forming an epitaxial cobalt silicide, where a thin layer of oxide **200** is formed on the surface of a silicon substrate **210**, this reads on applicants distributing a nonmetal element in a region in the vicinity of a surface portion a semiconductor layer (col 5, ln 20-50). Tung also discloses a cobalt layer **220** formed over the oxide layer using e-beam evaporation (col 5, ln 55-67) and after the cobalt layer is formed on the substrate, the substrate is annealed for an amount of time that is sufficient to convert the cobalt to cobalt silicide (col 6, ln 10-30).

Referring to claim 6, Tung teaches the same semiconductor layer, Silicon, and semiconductor-metal compound layer, cobalt silicide, but is silent to their crystal structures .It is inherent that the semiconductor layer and semiconductor-metal layer has a face centered cubic structure because Tung teaches the same layers as applicant.

Referring to claim 7, Tung teaches the same semiconductor layer, Silicon, and semiconductor-metal compound layer, cobalt silicide, but is silent to their crystal structures. . It is inherent that the semiconductor layer has a diamond or zinc blend structure and the semiconductor-metal layer has a calcium fluoride structure because Tung teaches the same layers as applicant.

Referring to claim 8, Tung teaches a silicon substrate with an oxide grown thereon and a cobalt film on the oxide film, where the Cobalt film is annealed to form cobalt silicide.

Claim Rejections - 35 USC § 103

6. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

7. Claims 2-14 are rejected under 35 U.S.C. 103(a) as being unpatentable over Tung (US 5,728,625) in view of Sugano et al (US 4,469,527).

Tung discloses a process for forming an epitaxial cobalt silicide, where a thin layer of oxide **200** is formed on the surface of a silicon substrate **210**, this reads on applicants distributing a nonmetal element in a region in the vicinity of a surface portion a semiconductor layer (col 5, ln 20-50). Tung also discloses a cobalt layer **220** formed over the oxide layer using e-beam evaporation (col 5, ln 55-67) and after the cobalt layer is formed on the substrate, the substrate is annealed for an amount of time that is sufficient to convert the cobalt to cobalt silicide (col 6, ln 10-30). Tung also discloses a silicon dioxide film can be removed by ion etching (col 7, ln 15-21) and forming a gate electrode **308**, a source **311** and a drain **312**.

Tung does not disclose distributing a nonmetal element in a region in the vicinity of a surface portion of a semiconductor layer.

In a method of making a semiconductor device, Sugano et al teaches a silicon substrate having a silicon oxide film on the surface thereof was irradiated with thermal neutron beams, so that lattice defects were produced throughout the silicon substrate to make it semi-insulating (col 11, ln 60-67 and col 12, ln 1-5). Sugano et al also teaches the surface of the silicon substrate was annealed by irradiating it with laser beam pulses, so that an activated layer was formed at the surface portion of the silicon substrate and the activated layer was exposed by removing the silicon oxide (col 12, ln 5-35). Sugano et al also teaches various types irradiation other than

thermal neutron beam can be used, such as electron beam and a high-speed neutron beam. Sugano et al also teaches an ion beam can be used in place of the laser beam (col 2, ln 50-67).

It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Tung with Sugano et al's semiconductor substrate because the electrostatic capacitance of the semiconductor device relative to ground is reduced, which shortens the delay time due to electrostatic capacitance, whereby the operative frequency band width is broadened and the operating speed is increased (col 2, ln 14-32).

Referring to claim 2-3, the combination of Tung and Sugano et al teaches a compound layer of silicon dioxide and an ion beam to form an activated layer at a surface portion of the silicon substrate. The combination of Tung and Sugano et al is silent to distributing a non-metal element included in the compound layer in the region in the vicinity of the surface portion of he semiconductor layer through recoil by irradiating the compound layer with a particle energy beam, but it is inherent to the combination of Tung and Sugano et al because the combination of Tung and Sugano et al teaches a similar irradiation of the compound layer with a particle beam, as applicant. The combination of Tung and Sugano et al teaches removing a compound layer, thereby exposing the activated layer.

Referring to claim 4, the combination of Tung and Sugano et al teaches the same semiconductor layer, semiconductor-metal layer and compound layer as applicant, therefore it is inherent that the semiconductor layer has a face centered cubic crystal structure and the semiconductor-metal compound layer has a face centered cubic structure and the compound layer is amorphous.

Referring to claim 5, the combination of Tung and Sugano et al teaches an ion beam, but is silent to the beam including a nonmetal element. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Tung and Sugano et al by including a nonmetal element such as argon.

Referring to claim 6, the combination of Tung and Sugano et al teaches the same semiconductor layer and semiconductor-metal layer as applicant, therefore it is inherent that the semiconductor layer has a face centered cubic crystal structure and the semiconductor-metal compound layer has a face centered cubic structure.

Referring to claim 7, the combination of Tung and Sugano et al teaches the same semiconductor layer, Silicon, and semiconductor-metal compound layer, cobalt silicide, but is silent to their crystal structures. It is inherent that the semiconductor layer has a diamond or zinc blend structure and the semiconductor-metal layer has a calcium fluoride structure because the combination of Tung and Sugano et al teaches the same layers as applicant.

Referring to claim 8, the combination of Tung and Sugano et al teaches a semiconductor layer of silicon, a nonmetal element of oxygen, a cobalt film and a cobalt silicide layer.

Referring to claim 9, the examiner interprets claim 9 to read as cm^{-3} because concentration is function of volume. The combination of Tung and Sugano et al is silent to the concentration of the oxygen. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Tung and Sugano et al by attempting to optimize the concentration of oxygen by conducting routine experimentations.

Referring to claim 10, the combination of Tung and Sugano et al teaches forming a silicon oxide layer on a silicon substrate and irradiating the silicon oxide film with an ion beam,

where it is inherent that the oxygen is distributed in the vicinity of the surface portion of the silicon layer.

Referring to claim 11, the combination of Tung and Sugano et al teaches a gate and a source and drain and distributing a non-metal element in a region of the surface portion of the semiconductor layer and a cobalt film deposited thereon and annealing to form a semiconductor-metal film of cobalt silicide.

Referring to claim 12, the combination of Tung and Sugano et al teaches forming a silicon oxide layer on a silicon substrate and irradiating the silicon oxide film with an ion beam, where it is inherent that the oxygen is distributed in the vicinity of the surface portion of the silicon layer. The combination of Tung and Sugano et al teaches also teaches removing the oxide to expose the activated layer.

Referring to claim 13, the combination of Tung and Sugano et al teaches a silicon layer, a silicon oxide layer, a cobalt film and a cobalt silicide layer.

Referring to claim 14, the examiner interprets claim 14 to read as cm^{-3} because concentration is function of volume. The combination of Tung and Sugano et al is silent to the concentration of the oxygen. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Tung and Sugano et al by attempting to optimize the concentration of oxygen by conducting routine experimentations

8. Claims 1-14 are rejected under 35 U.S.C. 103(a) as being unpatentable over Maa et al (US 5,830,775) in view of Sugano et al (US 4,469,527).

Maa et al discloses a gate structure **30**, a source **46** and a drain **48** on opposite side of the gate on a substrate **10**, where after the formation of the gate structure and implantation steps to create the source and drain, a layer of silicidation material **80** is deposited on the substrate. Maa et al also discloses the silicidation material is a uniform layer of Cobalt (col 4, ln 5-67). Maa et al also discloses a rapid thermal annealing, where the silicadation material reacts with areas of surface silicon to yield a silicon deficient silicide product of CoSi (col 5, ln 5-40). Maa et al also discloses removal of oxide from a silicon deficient silicide region by in-situ argon ion beam cleaning (col 6, ln 55-65).

Maa et al does not disclose distributing a nonmetal element in a region in the vicinity of a surface portion of a semiconductor layer.

In a method of making a semiconductor device, Sugano et al teaches a silicon substrate having a silicon oxide film on the surface thereof was irradiated with thermal neutron beams, so that lattice defects were produced throughout the silicon substrate to make it semi-insulating (col 11, ln 60-67 and col 12, ln 1-5). Sugano et al also teaches the surface of the silicon substrate was annealed by irradiating it with laser beam pulses, so that an activated layer was formed at the surface portion of the silicon substrate and the activated layer was exposed by removing the silicon oxide (col 12, ln 5-35). Sugano et al also teaches various types irradiation other than thermal neutron beam can be used, such as electron beam and a high-speed neutron beam. Sugano et al also teaches an ion beam can be used in place of the laser beam (col 2, ln 50-67).

It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Maa et al with Sugano et al's semiconductor substrate because the electrostatic capacitance of the semiconductor device relative to ground is reduced, which

shortens the delay time due to electrostatic capacitance, whereby the operative frequency band width is broadened and the operating speed is increased (col 2, ln 14-32).

Referring to claim 2, the combination of Maa et al and Sugano et al teaches a compound layer of silicon dioxide and an ion beam to form an activated layer at a surface portion of the silicon substrate. The combination of Maa et al and Sugano et al is silent to distributing a non-metal element included in the compound layer in the region in the vicinity of the surface portion of he semiconductor layer through recoil by irradiating the compound layer with a particle energy beam, but it is inherent to the combination of Maa et al and Sugano et al because the combination of Maa et al and Sugano et al teaches a similar irradiation of the compound layer with a particle beam. The combination of Maa et al and Sugano et al teaches removing a compound layer, thereby exposing the activated layer.

Referring to claim 3, the combination of Maa et al and Sugano et al teaches a compound layer of silicon dioxide and an ion beam to form an activated layer at a surface portion of the silicon substrate. The combination of Maa et al and Sugano et al is silent to distributing a non-metal element included in the compound layer in the region in the vicinity of the surface portion of he semiconductor layer through recoil by irradiating the compound layer with a particle energy beam, but it is inherent to the combination of Maa et al and Sugano et al because the combination of Maa et al and Sugano et al teaches a similar irradiation of the compound layer with a particle beam. The combination of Maa et al and Sugano et al teaches removing a compound layer, thereby exposing the activated layer and oxide removed by an argon ion beam.

Referring to claim 4, the combination of Maa et al and Sugano et al teaches the same semiconductor layer, semiconductor-metal layer and compound layer as applicant, therefore it is

inherent that the semiconductor layer has a face centered cubic crystal structure and the semiconductor-metal compound layer has a face centered cubic structure and the compound layer is amorphous.

Referring to claim 5, the combination of Maa et al and Sugano et al teaches an Ar ion beam.

Referring to claim 6, the combination of Maa et al and Sugano et al teaches the same semiconductor layer and semiconductor-metal layer as applicant, therefore it is inherent that the semiconductor layer has a face centered cubic crystal structure and the semiconductor-metal compound layer has a face centered cubic structure.

Referring to claim 7, the combination of Maa et al and Sugano et al teaches the same semiconductor layer, Silicon, and semiconductor-metal compound layer, cobalt silicide, but is silent to their crystal structures. It is inherent that the semiconductor layer has a diamond or zinc blend structure and the semiconductor-metal layer has a calcium fluoride structure because the combination of Maa et al and Sugano et al teaches the same layers as applicant.

Referring to claim 8, the combination of Maa et al and Sugano et al teaches a semiconductor layer of silicon, a nonmetal element of oxygen, a cobalt film and a cobalt silicide layer.

Referring to claim 9, the examiner interprets claim 9 to read as cm^{-3} because concentration is function of volume. The combination of Maa et al and Sugano et al is silent to the concentration of the oxygen. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Maa et al and Sugano et al by attempting to optimize the concentration of oxygen by conducting routine experimentations.

Referring to claim 10, the combination of Maa et al and Sugano et al teaches forming a silicon oxide layer on a silicon substrate and irradiating the silicon oxide film with an ion beam, where it is inherent that the oxygen is distributed in the vicinity of the surface portion of the silicon layer.

Referring to claim 11, the combination of Maa et al and Sugano et al teaches a gate and a source and drain and distributing a non-metal element in a region of the surface portion of the semiconductor layer and a cobalt film deposited thereon and annealing to form a semiconductor-metal film of cobalt silicide.

Referring to claim 12, the combination of Maa et al and Sugano et al teaches forming a silicon oxide layer on a silicon substrate and irradiating the silicon oxide film with an ion beam, where it is inherent that the oxygen is distributed in the vicinity of the surface portion of the silicon layer. The combination of Maa et al and Sugano et al teaches also teaches removing the oxide to expose the activated layer.

Referring to claim 13, the combination of Maa et al and Sugano et al teaches a silicon layer, a silicon oxide layer, a cobalt film and a cobalt silicide layer.

Referring to claim 14, the examiner interprets claim 14 to read as cm^{-3} because concentration is function of volume. The combination of Maa et al and Sugano et al is silent to the concentration of the oxygen. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Maa et al and Sugano et al by attempting to optimize the concentration of oxygen by conducting routine experimentations.

9. Claims 9 and 14 are rejected under 35 U.S.C. 103(a) as being unpatentable over Maa et al (US 5,830,775) in view of Sugano et al (US 4,469,527) as applied to claims 1-8 and 10-13 above, and further in view of Yamazaki et al (US 5,956,579).

The combination of Maa et al and Sugano et al teaches all of the limitations of claim 9, as discussed previously in claim 8. If the concentration of oxygen is not a result effective variable then the combination of Maa et al and Sugano et al does not teach an oxygen concentration of 4×10^{14} through 4×10^{15} cm^{-3}, where the examiner interprets claim 9 to read as cm^{-3} because concentration is a function of volume.

In a method of obtaining crystalline semiconductors, Yamazaki et al teaches amorphous silicon is coated with cobalt and annealed at a temperature to form cobalt silicide and crystalline silicon (col 2, ln 5-67 and col 3, ln 1-15). Yamazaki et al also teaches an oxygen concentration in the amorphous silicon is below 1×10^{19} cm^{-3} in order to obtain a good crystallinity. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Maa et al and Sugano et al with Yamazaki et al's oxygen concentration because good crystallinity in the silicon layer is obtained.

The combination of Maa et al, Sugano et al and Yamazaki et al teaches a concentration of less then 1×10^{19} cm^{-3}, which is in the range of applicant. Overlapping ranges is prima facia obviousness.

Referring to claim 19, the combination of Maa et al, Sugano et al and Yamazaki et al teaches a concentration of less then 1×10^{19} cm^{-3}, which is in the range of applicant. Overlapping ranges is prima facia obviousness.

Conclusion

10. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

Mizutani et al (US 5,314,839) teaches a SiO_2 layer on a silicon substrate is irradiated with Argon beams, where the chemical stability of the layer is increased (col 6, ln 20-45 and col 4, ln 1-50).

11. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Matthew J Song whose telephone number is 703-305-4953. The examiner can normally be reached on M-F 9:00-5:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Benjamin L Utech can be reached on 703-308-3868. The fax phone numbers for the organization where this application or proceeding is assigned are 703-872-9310 for regular communications and 703-872-9311 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0661.

Matthew J Song
Examiner
Art Unit 1765

mjs
August 1, 2002

Felisa Hiteshew

FELISA HITESHEW
PRIMARY EXAMINER
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